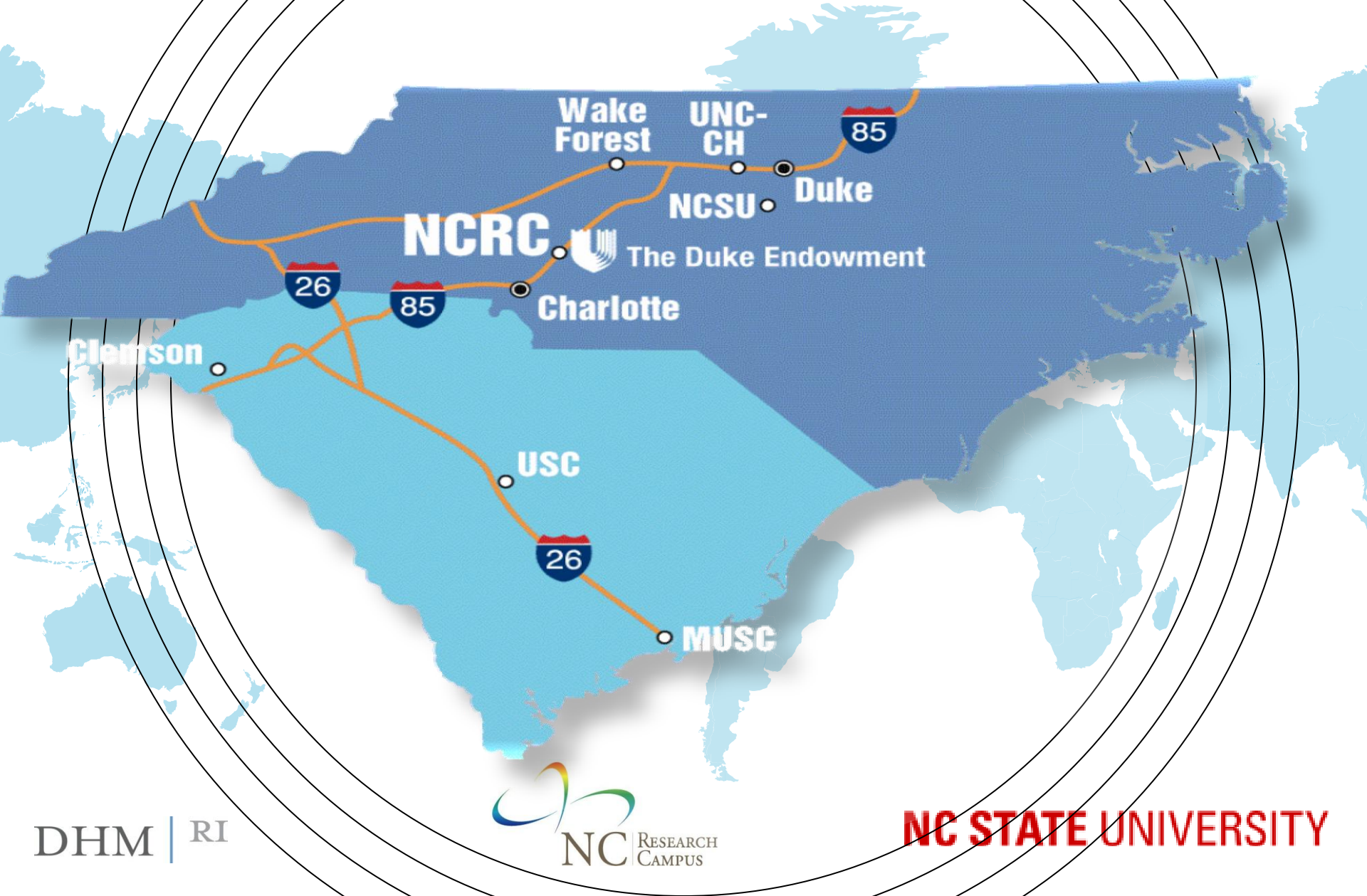
SUPERFRUITS IN THE HEALTH/SCIENCE SPOTLIGHT

NCRC- near Charlotte, NC, east coast USA



DHM | RI

NC Research Campus

NC STATE UNIVERSITY

Leading discovery and delivery of innovative plant-based solutions to advance human health & wellness

NC STATE UNIVERSITY

Plants for Human Health

INSTITUTE

1. Whole Foods
2. Functional foods
3. Dietary supplements
4. Medical foods
5. Phytopharmaceuticals

Characteristics of a Superfruit

Superfruit NUTRITIVE VALUE

Superfruit PHYTOACTIVES (bioactive compounds)

Bioactive phytochemicals a.k.a. *phytoactives*: natural compounds in fruits vegetables nuts and grains which positively impact on human health

Fruits & Berries
Vegetables
Nuts
Tea
Cocoa
Coffee






Origin of Superfruits & their Phytoactives

"Stressed for Success"

DNA-protective

antiviral

antimicrobial

antiadhesin

free-radical scavenging

ADD-therapeutic

UTI-inhibition

antidiabetic

cancer-chemopreventive

SUPERFRUITS

cardioprotective

anti-osteoporosis

neuroprotective

estrogen antagonism

antiproliferative

enzyme activating/inhibiting

iron chelating

neuronal signaling

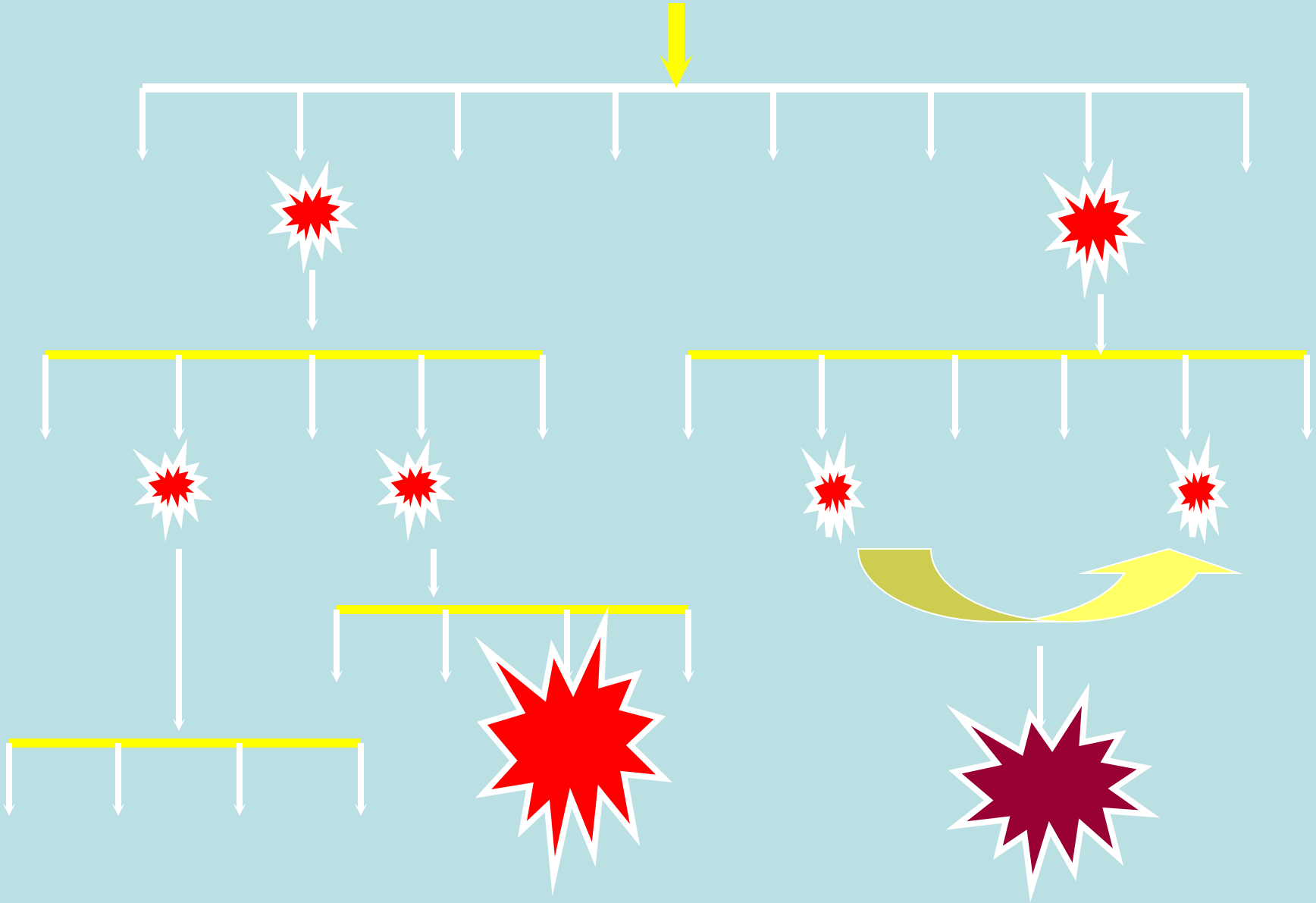
antioxidant

membrane-modulating

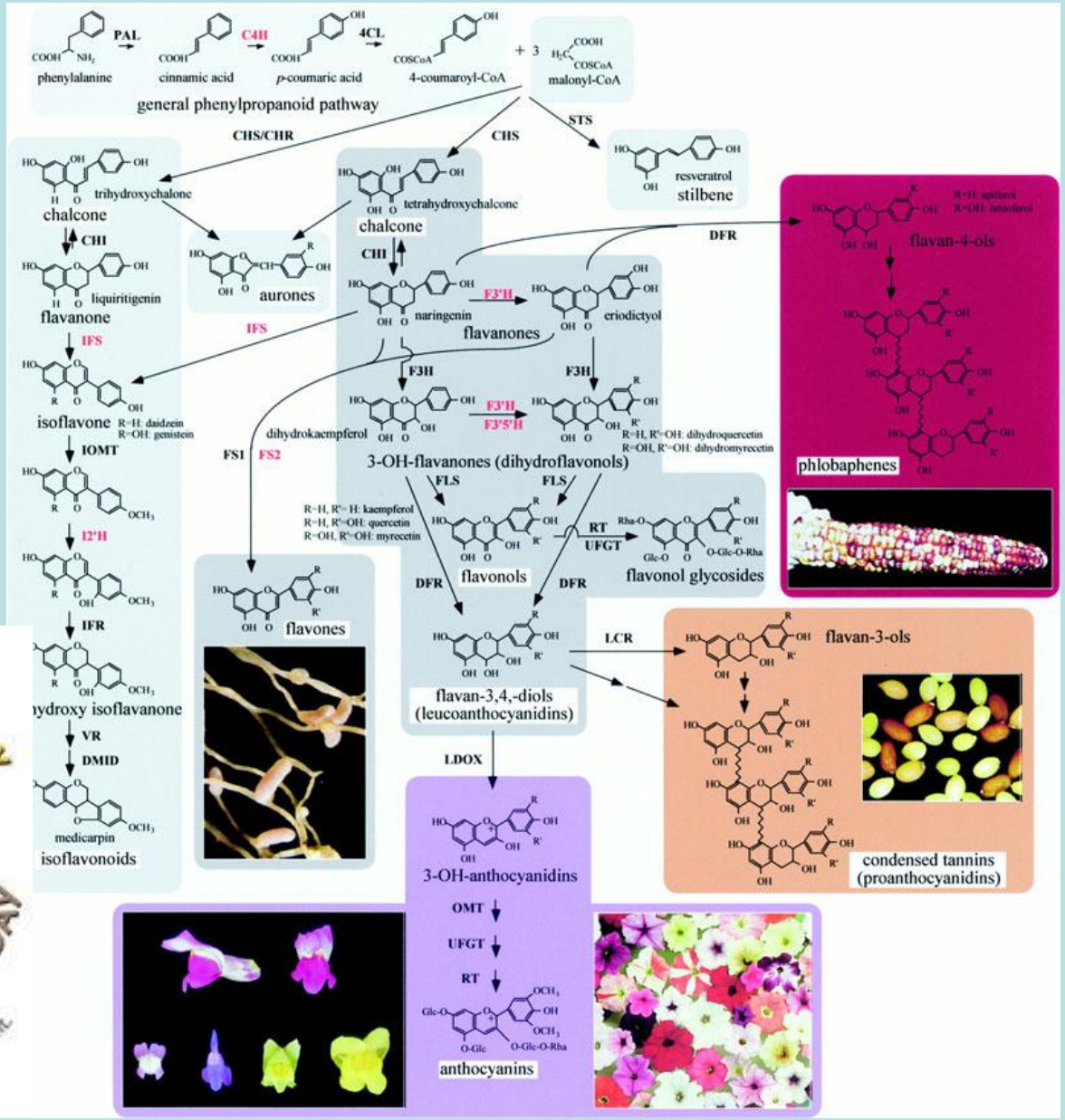
anti-inflammatory

Interacting mixtures
Breakdown metabolites
Multiplicity of bioactivities
Difficult to pinpoint bioavailability

Phytoactives in a FRUIT extract

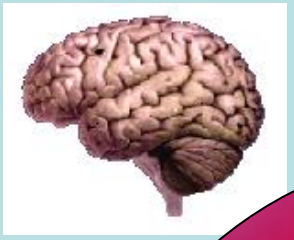


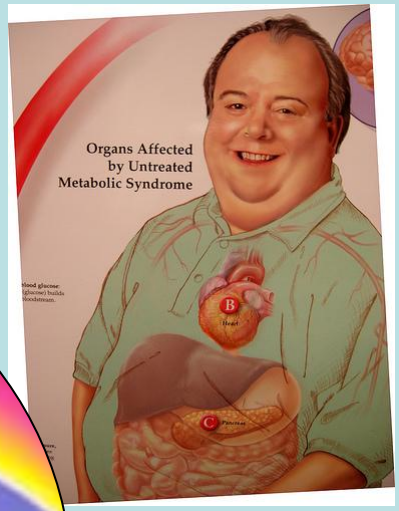

5 A DAY THE COLOR WAY
RED
YELLOW/ORANGE
BLUE/PURPLE
WHITE
GREEN
EAT YOUR COLORS EVERY DAY
Get the variety of vitamins, minerals and phytochemicals you need to stay healthy & fit.


PAL
C4H
4CL
phenylalanine
cinnamic acid
p-coumaric acid
4-coumaroyl-CoA
malonyl-CoA
general phenylpropanoid pathway
CHS/CHR
CHS
STS
resveratrol
stilbene
trihydroxychalone
chalcone
tetrahydroxychalone
chalcone
CHI
liquiritigenin
flavanone
aurones
IFS
naringenin
F3'H
eriodictyol
flavanones
DFR
flavan-4-ols
R=H: apiforol
R=OH: luteoforol
isoflavone
R=H: daidzein
R=OH: genistein
IOMT
I2'H
IFR
hydroxy isoflavanone
VR
DMID
medicarpin
isoflavonoids
F3H
F3'H
F3'5'H
dihydrokaempferol
R=H, R'=OH: dihydroquercetin
R=OH, R'=OH: dihydromyrecetin
3-OH-flavanones (dihydroflavonols)
FS1
FS2
FLS
R=H, R'=H: kaempferol
R=H, R'=OH: quercetin
R=OH, R'=OH: myrecetin
RT
UFGT
flavonol glycosides
flavonols
phlobaphenes
flavones
LCR
flavan-3-ols
flavan-3,4,-diols
(leucoanthocyanidins)
LDOX
condensed tannins
(proanthocyanidins)
3-OH-anthocyanidins
OMT
UFGT
RT
anthocyanins

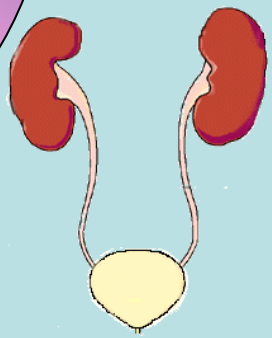
Multiplicity of bioactivities

http://www.thespoof.com/news/spoof.cfm?headline=s5i82852

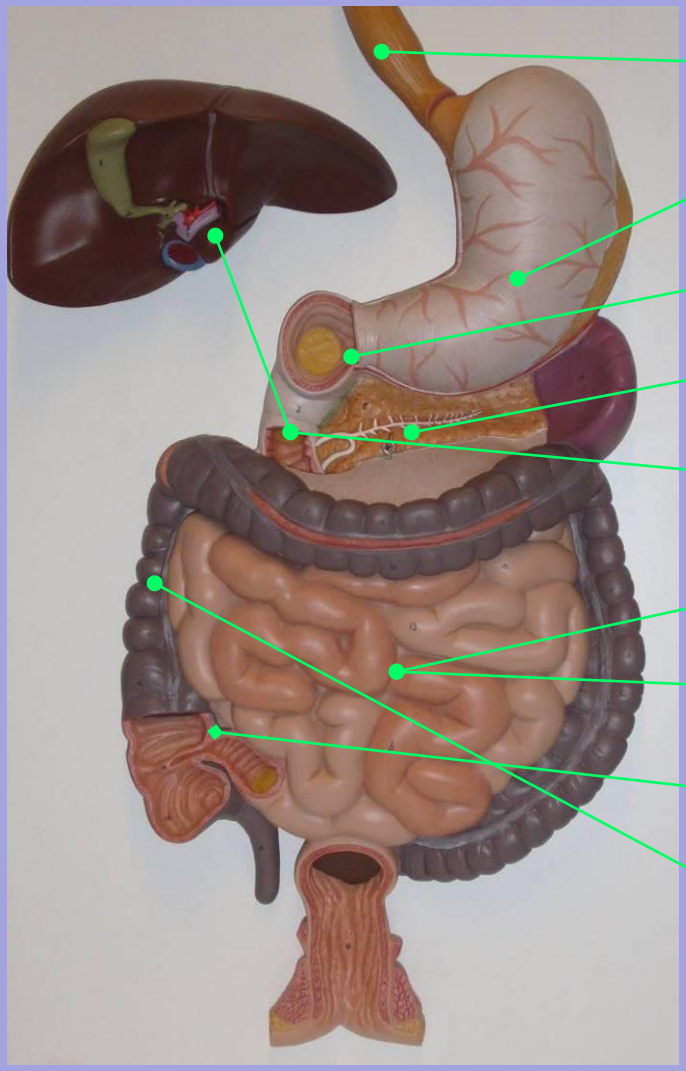




American Cancer Society



GI Tract Features Successive Dynamic Conditions



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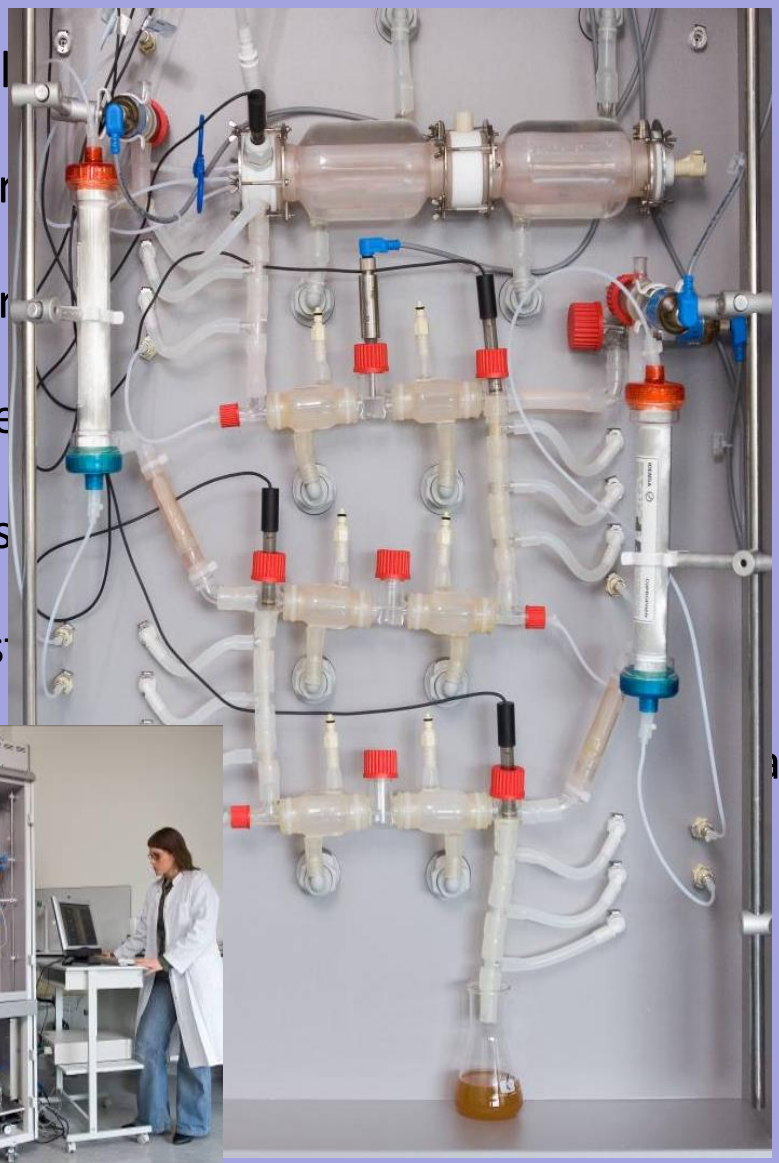

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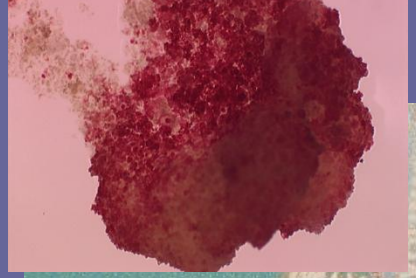

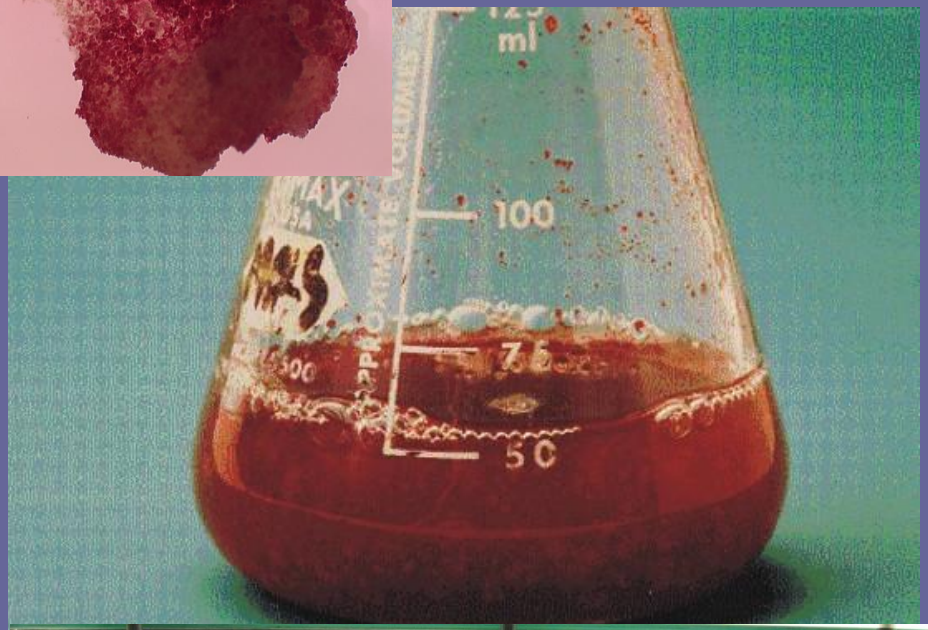

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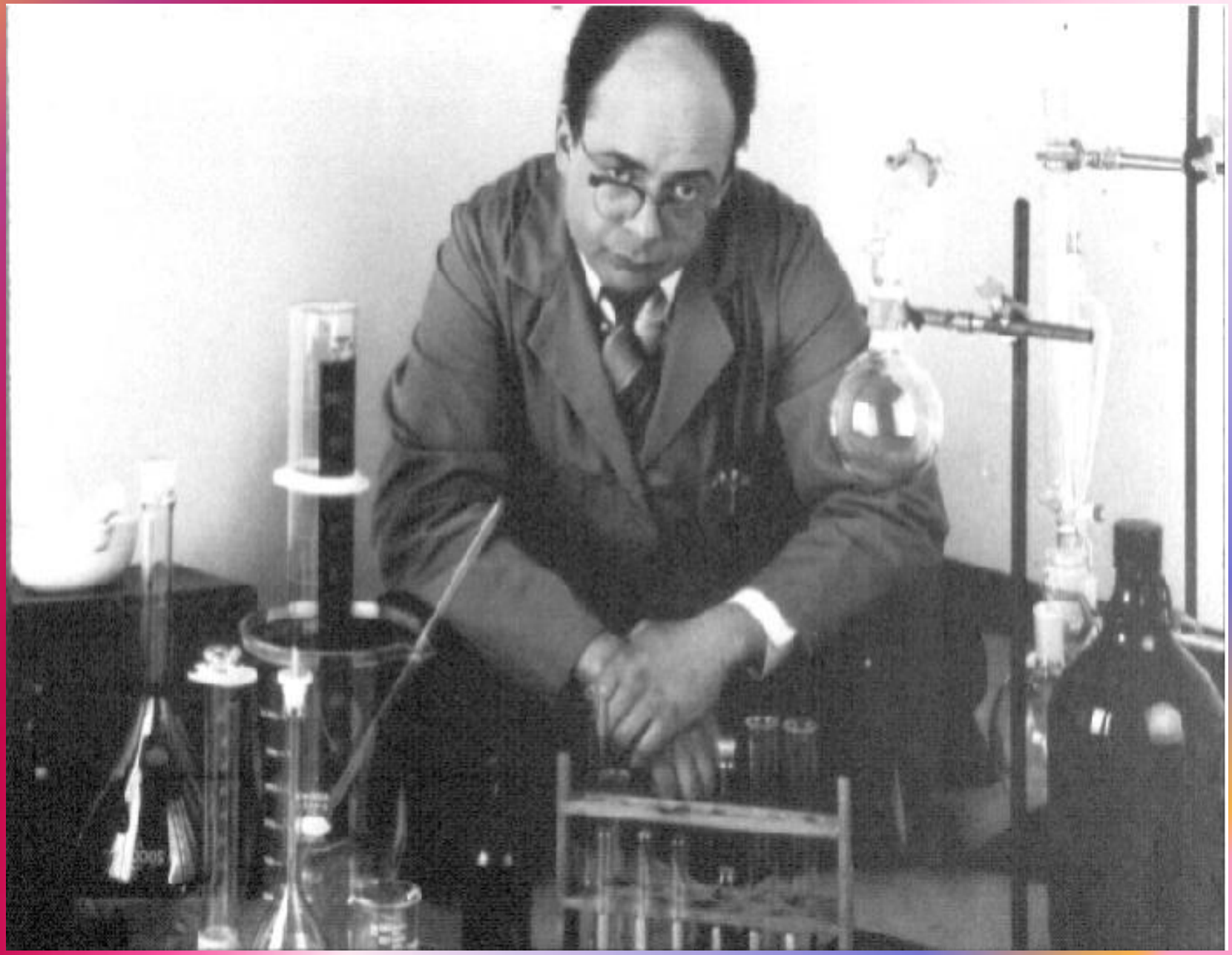
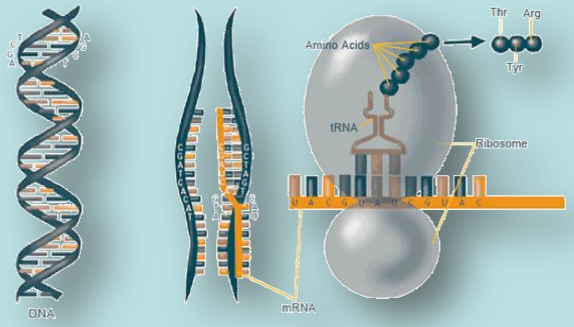
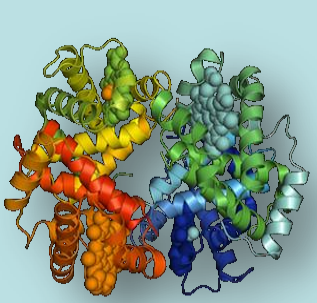
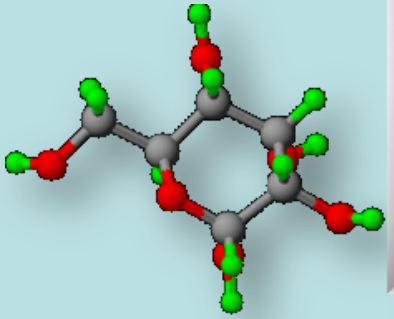
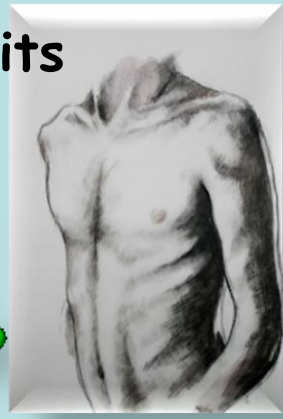


'omics Strategies to Pinpoint the Health Benefits of Superfruits

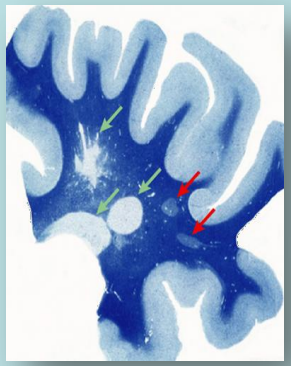




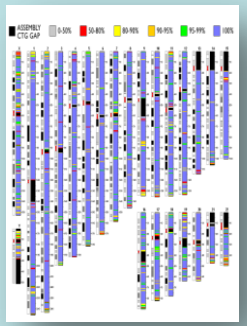




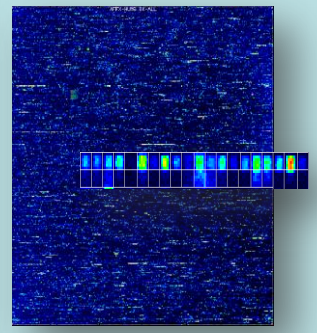
DNA N~$3x10^9$ ⟹ **RNA** N~$6x10^4$ ⟹ **Protein** N~10^6 → **Modified Proteins** N~10^7 **Enzymes** → **Metabolites** N~$6x10^3$



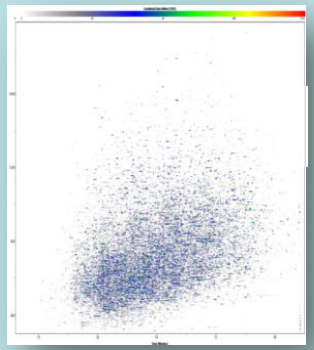
ENVIRONMENT



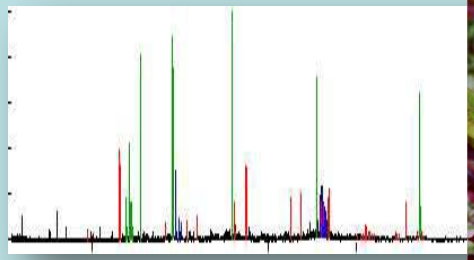
Genome



Transcriptome



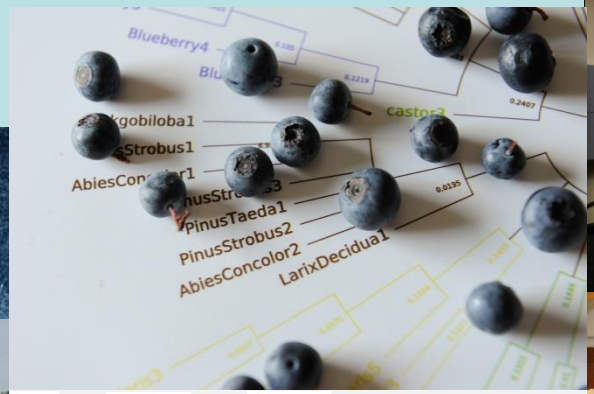
Proteome

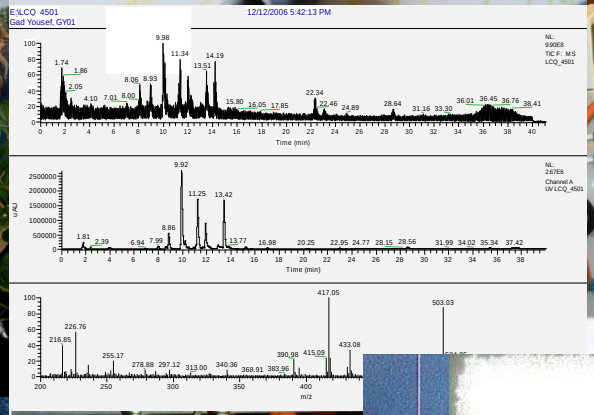


Metabolome

Modified from GD Lewis, R Gerszten et. al. JACC 2008;52;118

Superfruits Scrutinized | Genomics & Metabolomics





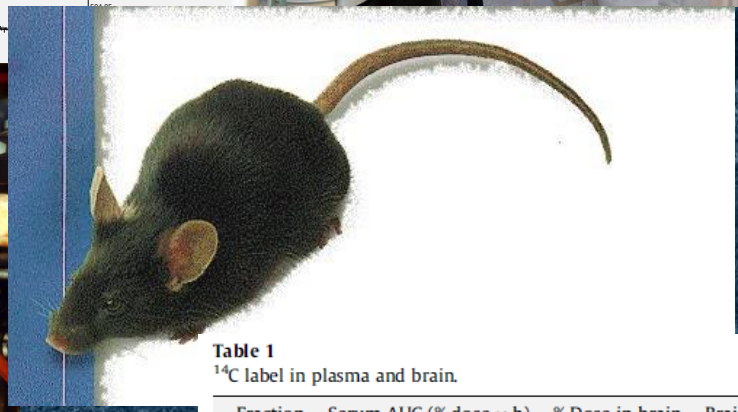


Table 1
^{14}C label in plasma and brain.

Fraction	Serum AUC (% dose × h)	% Dose in brain	Brain ^{14}C/serum AUC
I	1.34	.007%	0.0050
II	0.82	.016%	0.0200
III	1.11	.011%	0.0101
IV	2.07	.125%	0.0605
V	3.46	.119%	0.0343

Characteristics of a Superfruit

Superfruit NUTRITIVE VALUE

Superfruit PHYTOACTIVES (bioactive compounds)

Superfruit ORGANOLEPTIC PROPERTIES

Superfruit WHOLE FRUIT (not supplements)

Superfruit EXOTIC ALLURE

Superfruit| Science in the Marketplace

Why we eat what we eat

Sensual / physiological reasons

That smells good
That looks good
That tastes good

I'm hungry

I'm tired

Unlike plants, we can't make our own food, so we must eat; we are *heterotrophs*

Social / emotional reasons

It's my wife's favorite dish

It's a traditional dish

I'm depressed

It's my birthday

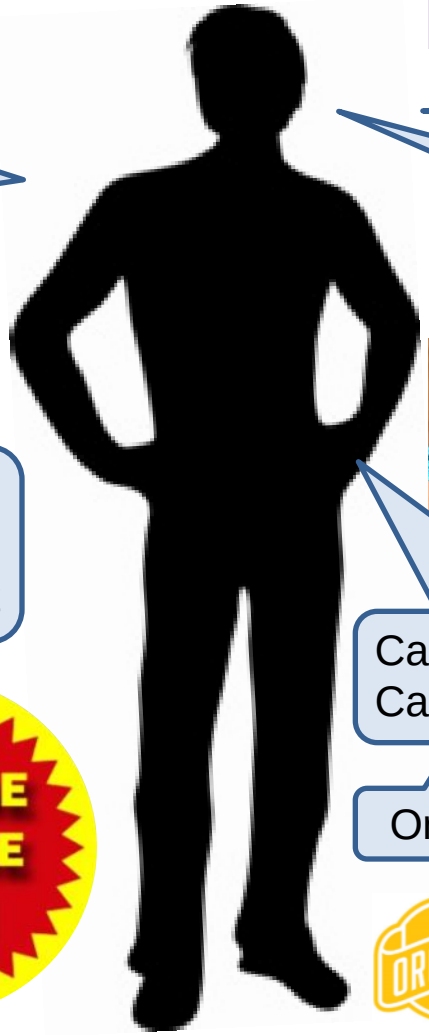
Superfruit| Science in the Marketplace

How consumers decide what to buy (to eat)

Economic reasons

I can't afford to buy fresh fruit

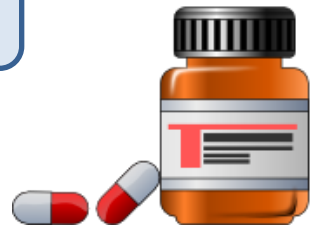
I don't have time to cook – we'll have take out tonight



Media and marketing

It's a superfood

I will be healthier if I take a multivitamin pill



I need to detox

Carbohydrates are bad
Carbohydrates are good

Organic is healthier

Image courtesy of acclaimclipart.com

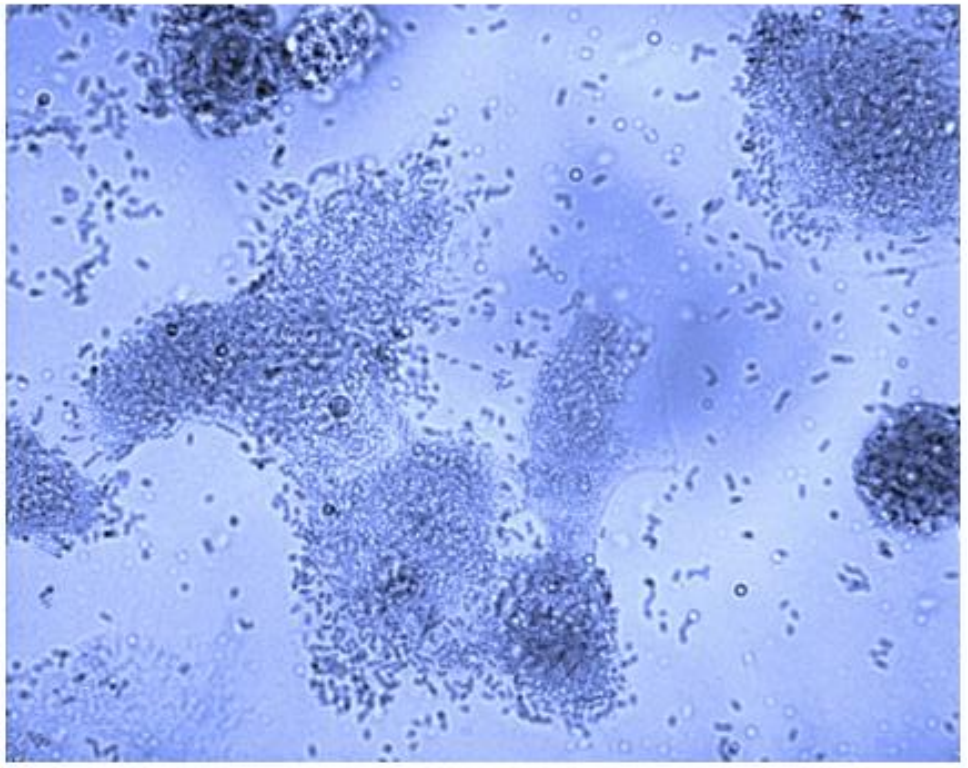
Why Superfruits?

Impact in the Marketplace

(who is buying, who is not, and why?)

the hype, the science, & marriage of the two

CASE STUDIES



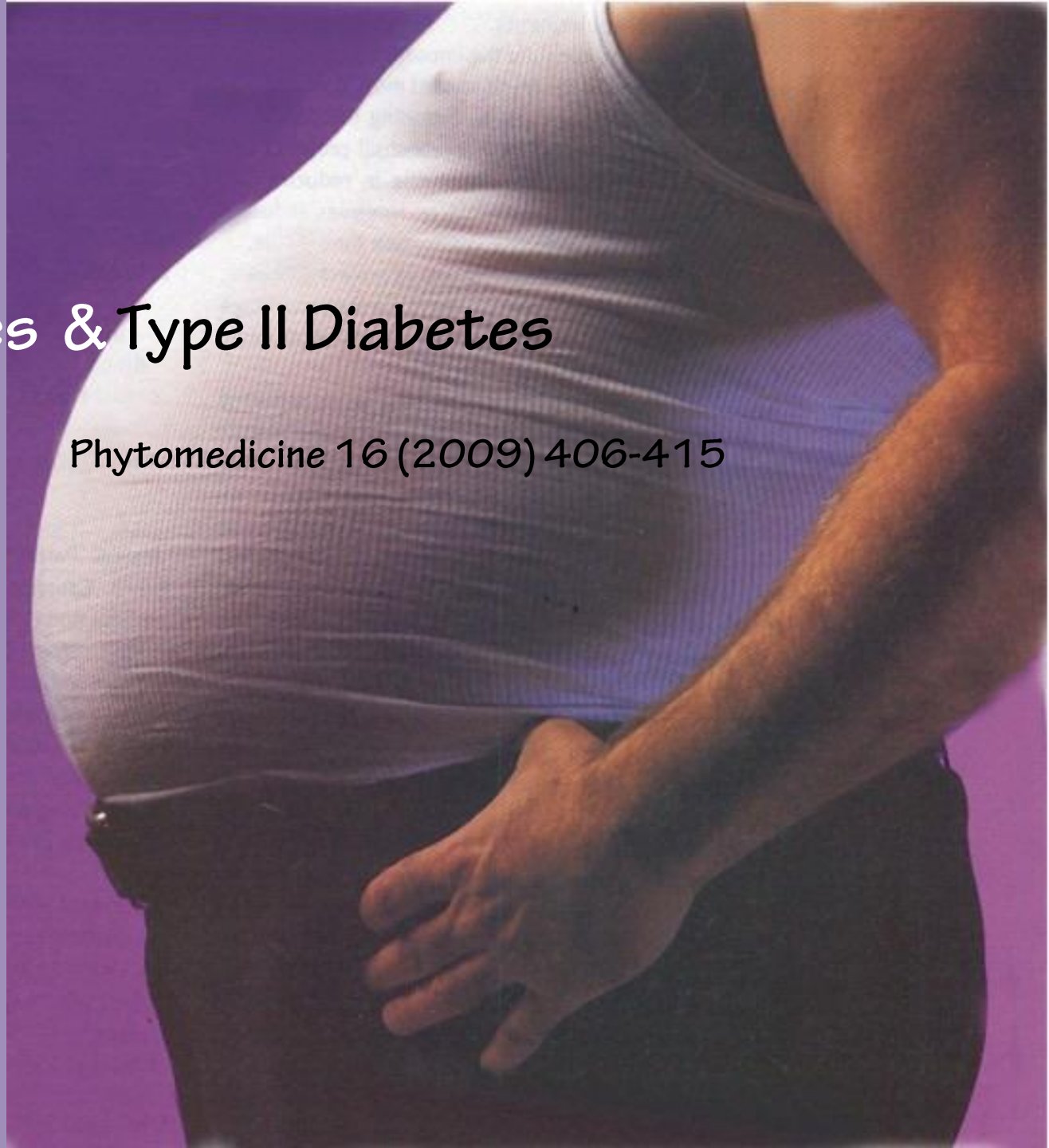
http://www.healthier-harvest.com/images/blueberries.jpg

the hype, the science, & marriage of the two


THE UNIVERSITY OF
MAINE

Blueberries & Type II Diabetes

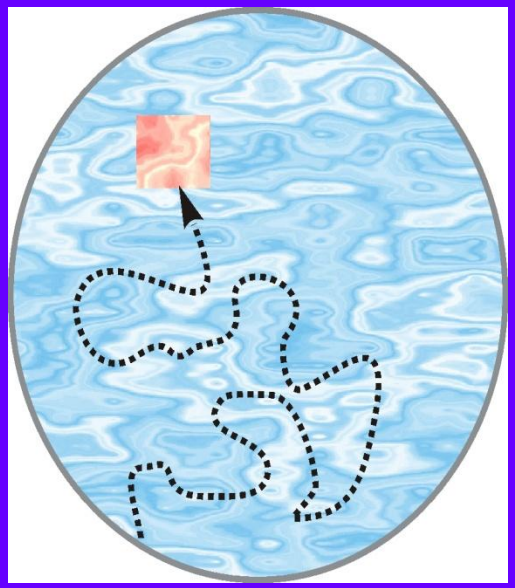
Phytomedicine 16 (2009) 406-415

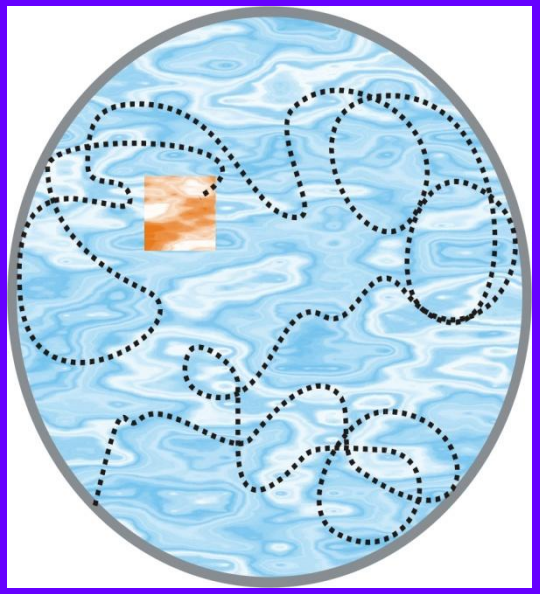


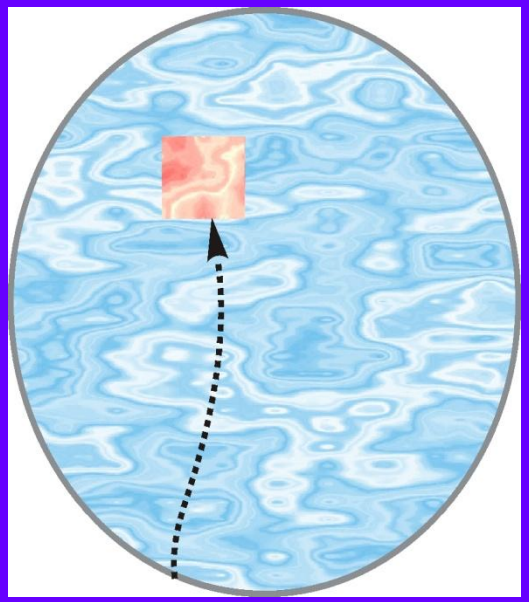
Hyperglycemia (elevated blood glucose) = hallmark of diabetes

Metformin = pharmaceutical anti-diabetic drug;
rapidly lowers high blood sugar levels

Blueberry Anthocyanins have blood glucose lowering capacity







Berries & Gut Health

In vitro pure cultures:

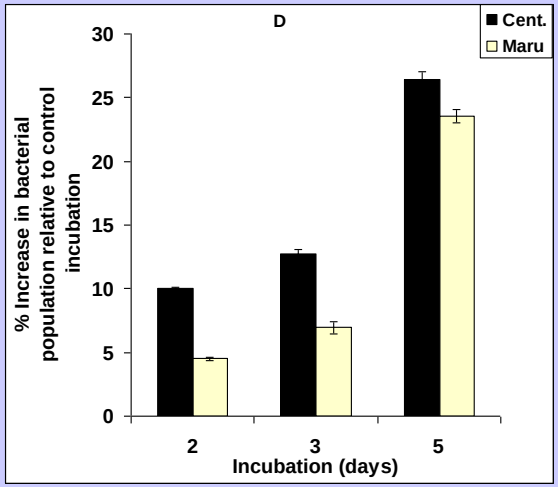
Increase in Lactobacillus and Bifidobacterium colonies; decrease E. coli

In vitro mixed batch cultures:

Increase in Lactobacillus and Bifidobacterium colonies; decrease E. coli

In vivo rat trials:

Increase in Lactobacillus and Bifidobacterium colonies; decrease E. coli



SCIENCE SWAYS THE MARKETPLACE

The Health Story

WILD BLUEBERRIES
The POWER of Blue™

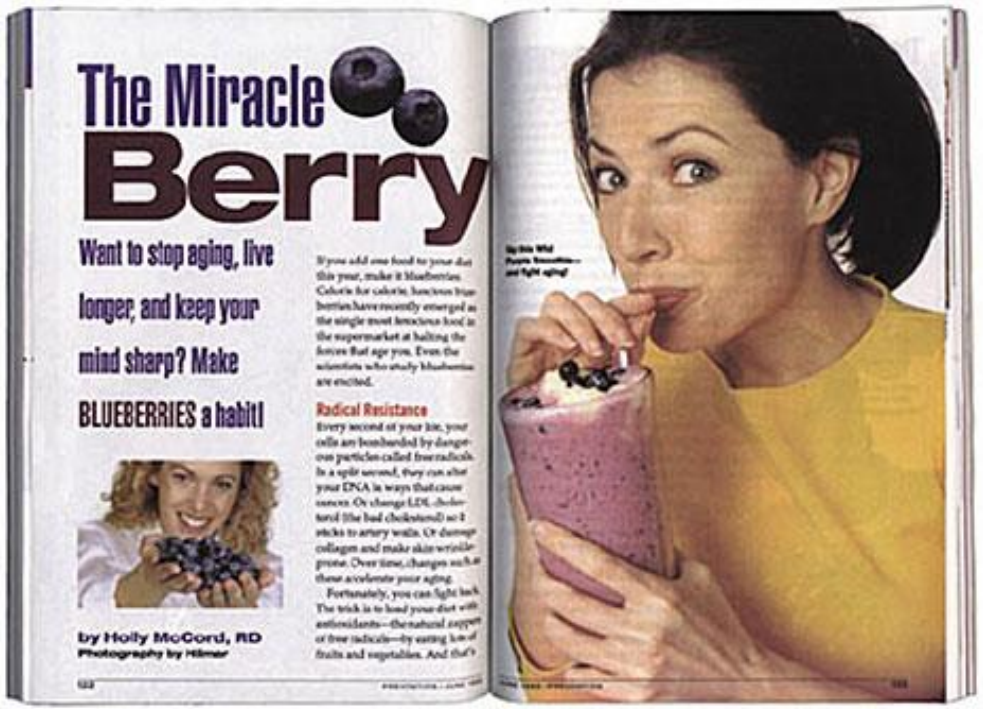
"From something in a muffin to a health icon"

We didn't change the blueberry,
we changed the way people think about it

Wild Blueberries
Nature's Great Taste

SWARDLICK
MARKETING GROUP

Breakthrough Health Communications



Wild Blueberries
Nature's Great Taste

Swardlick Marketing Group

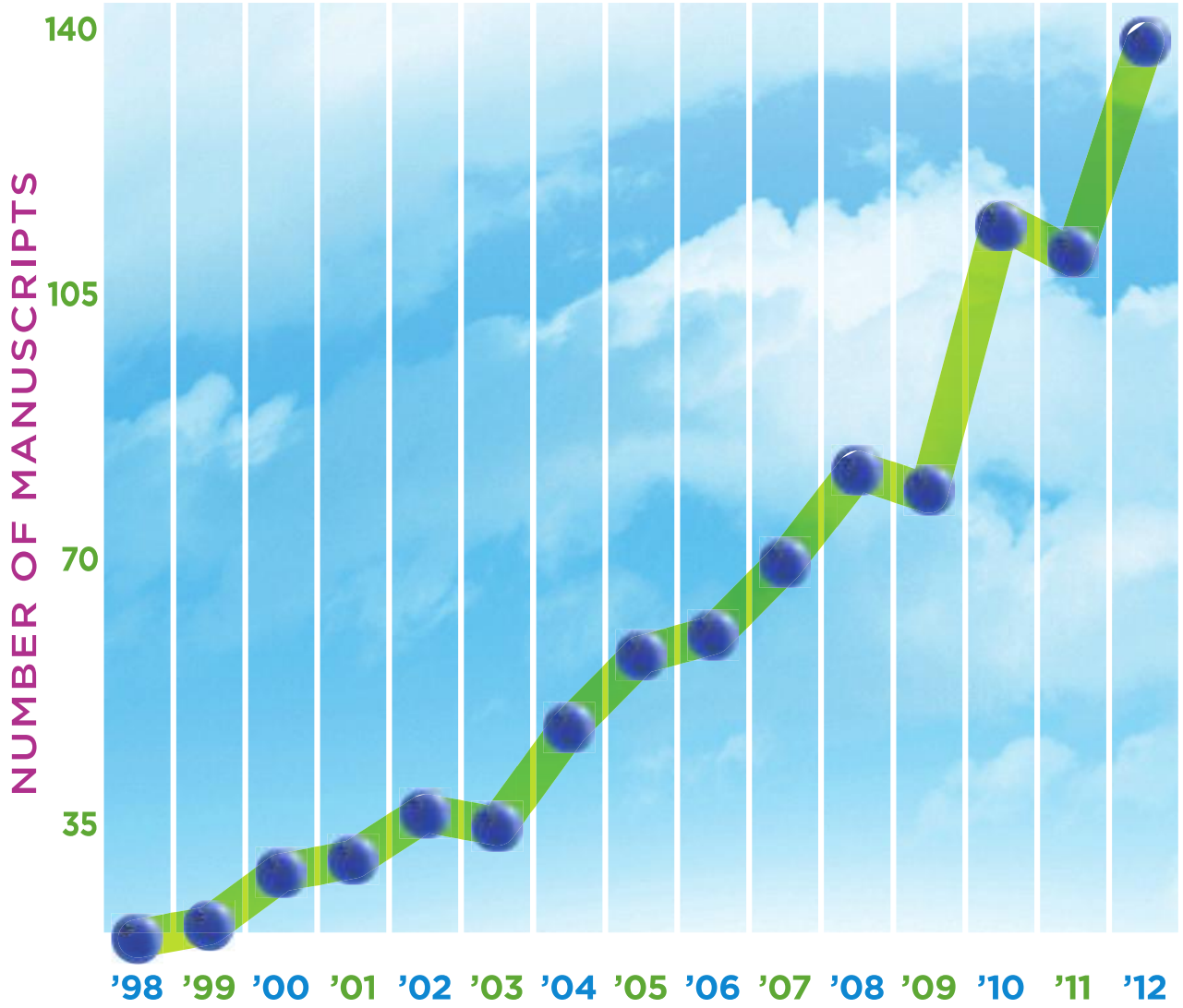
Breakthrough Health Communications

Science impacts the marketplace

- Science ……..and the trickle-down effect

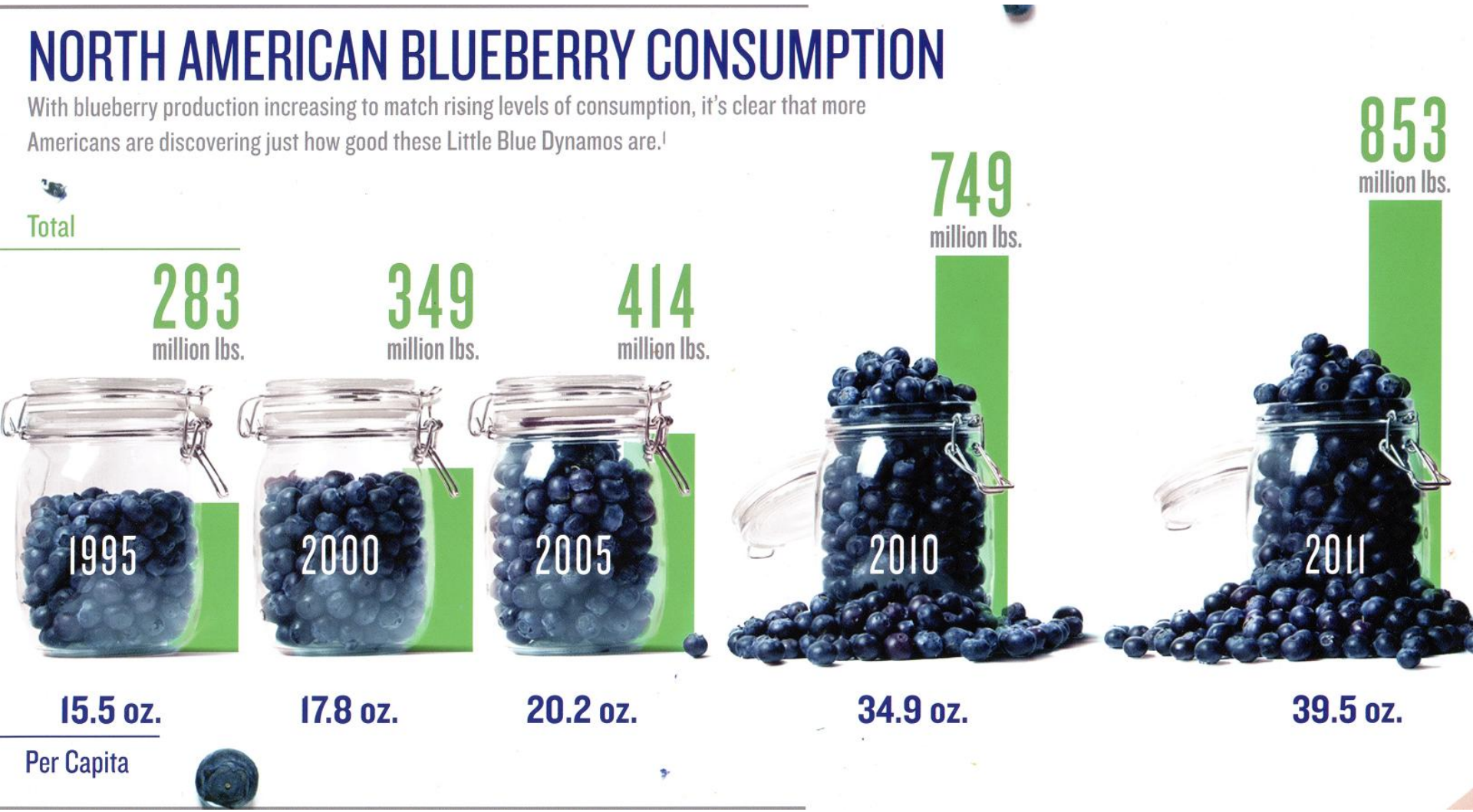
Blueberry Research Gone Wild!

BLUEBERRY/BILBERRY PUBLISHED HEALTH STUDIES

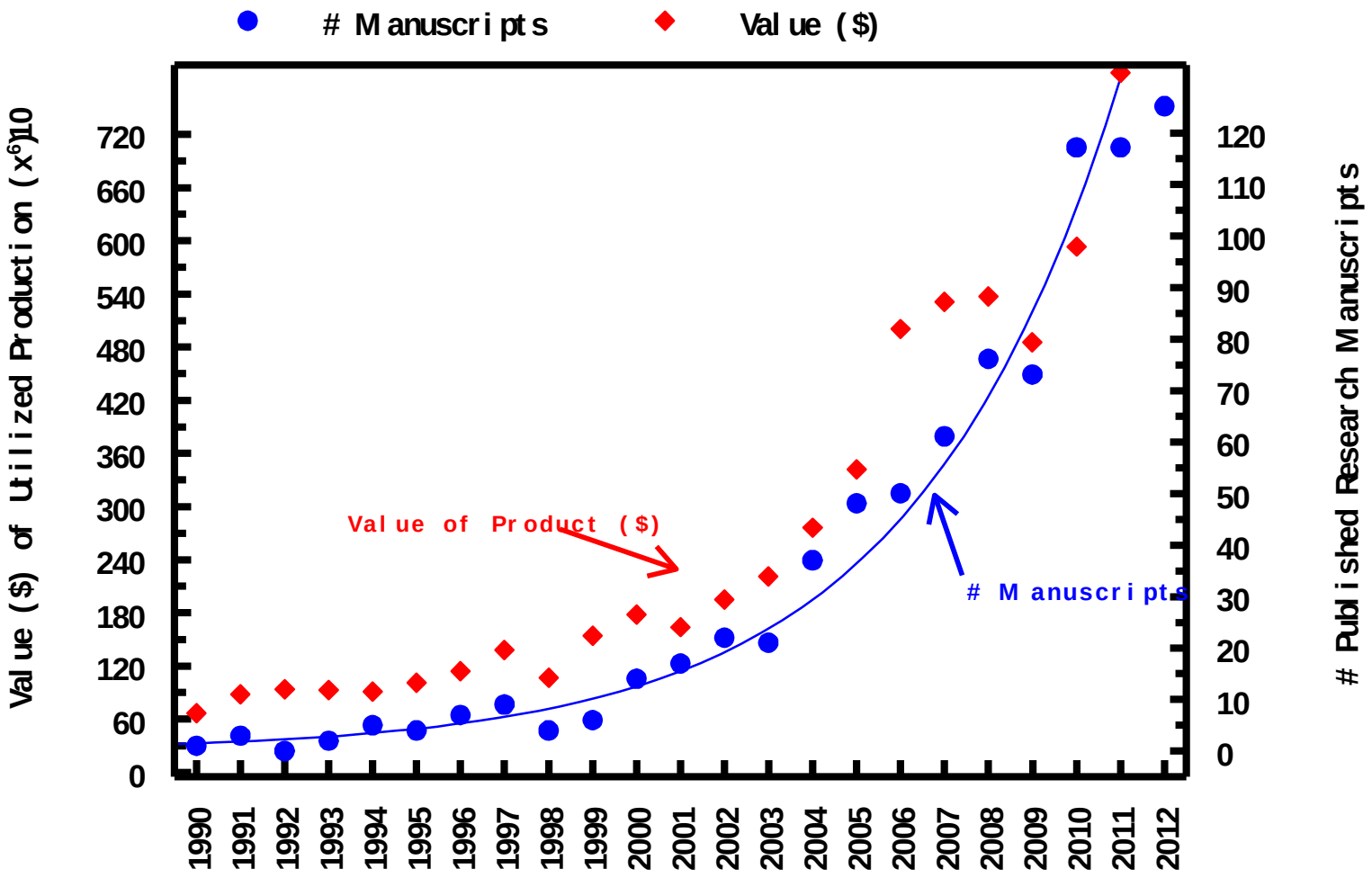


NORTH AMERICAN BLUEBERRY CONSUMPTION

With blueberry production increasing to match rising levels of consumption, it's clear that more Americans are discovering just how good these Little Blue Dynamos are.[1]



Impact of Science Communications on Product Value (Blueberries)



Sources: USDA, ERS, May 2012

Pubmed/EBSCO searches by R. Prior, 2012


Appalachian
STATE UNIVERSITY
Dole
NUTRITION INSTITUTE
NC STATE UNIVERSITY
Plants for Human Health
INSTITUTE
nutrasorb
YOUR HEALTH IS OUR SCIENCE
Influence of a blueberry-enriched protein powder on exercise-induced inflammation and oxidative stress in athletes: Metabolomics Approach
ASU-NCRC HUMAN PERFORMANCE LABORATORY

Trained distance runners.
Blueberry & green tea
& protein treatments.

Competitive long-distance runners ran for 2.5 h/d on treadmills at ~70% VO_{2max} for 3 d in a row.

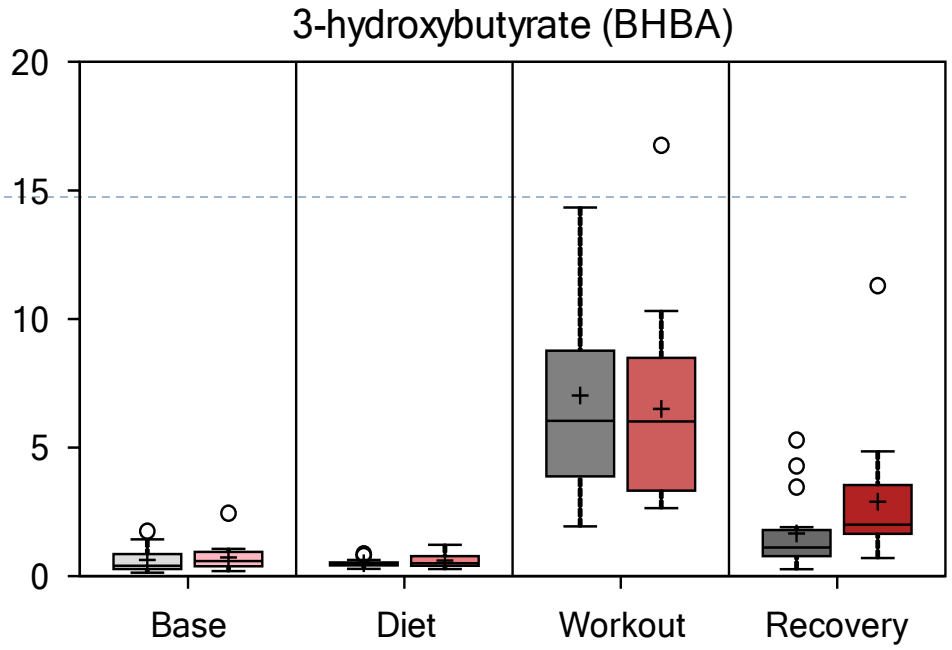
This was an intensified period of exercise for these runners, inducing "overreaching".

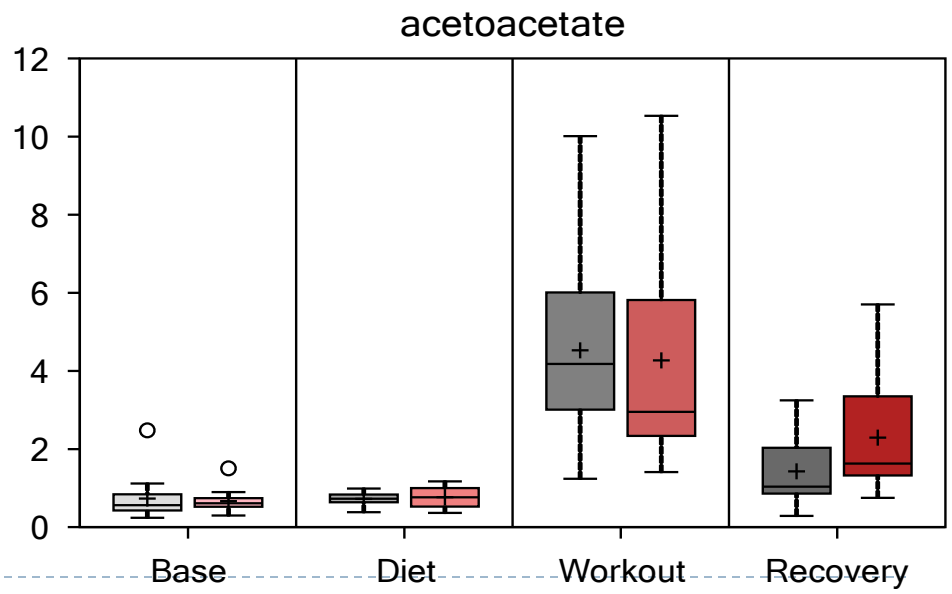
Runners supplemented with the blueberry/green tea protein supplement continued to utilize fatty acids during recovery (14 h post exercise).

- Fatty acid oxidation and ketogenesis were strongly induced by exercise in both groups, with elevations in ketones more evident at 14-h recovery in the treatment group ($P<0.05$).

PolyPhenolics Supplement Increases Ketogenesis and Fat Oxidation During 14-h Recovery

- Treament was linked to enhanced ketogenesis throughout 14-h recovery.
    - This indicates enhanced fat oxidation.





Superfruits Seasonal Gluts & Waste

Edible Protein

Mix and adjust
pH and temp

BBJ (blueberry juice)

BB Polyphenol-Enriched
Soy Protein matrix

Separate
(centrifugation)

BBJ after matrix removal

Ingredient

Functional Foods
Dietary Supplements
Cosmeceuticals

Concentrate

65° Brix

Sweeteners
Flavors
Colorants

Nutrasorb™

Nutrasorb-Zambia

Funded by Bill & Melinda Gates Foundation
Grand Challenges Explorations

Goals of Phase I: Develop and validate an innovative, portable and stable protein-rich food ingredient fortified with bioactives from local fruits

Targeted Population: Children and pregnant and nursing mothers

NC STATE UNIVERSITY
Plants for Human Health
INSTITUTE

nutrasorb
YOUR HEALTH IS OUR SCIENCE

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

Close to 45% of Zambian Children Experience Hidden Hunger or Malnutrition

Zambian Infant Mortality Rate is 65/1,000 live births (23/222)

https://www.cia.gov/library/publications/the-world-factbook/geos/za.html#

Ground Nut (Peanut) is the Main Source of Protein

Full Fat Soy Cake (Before)

Spread into Thin Layer

Juice-Flour
3:1

Juice-Flour
2:1

Dried in Vacuum Oven

Mango-flour paste inside the oven

After 4 hours of drying at 45°C

Dried flakes

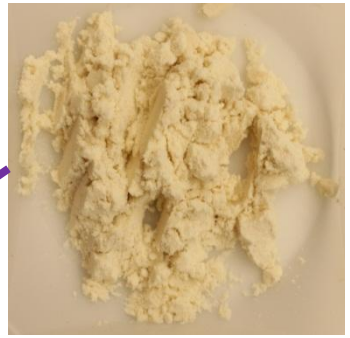
Ground powder

Noble Muscadine Grape

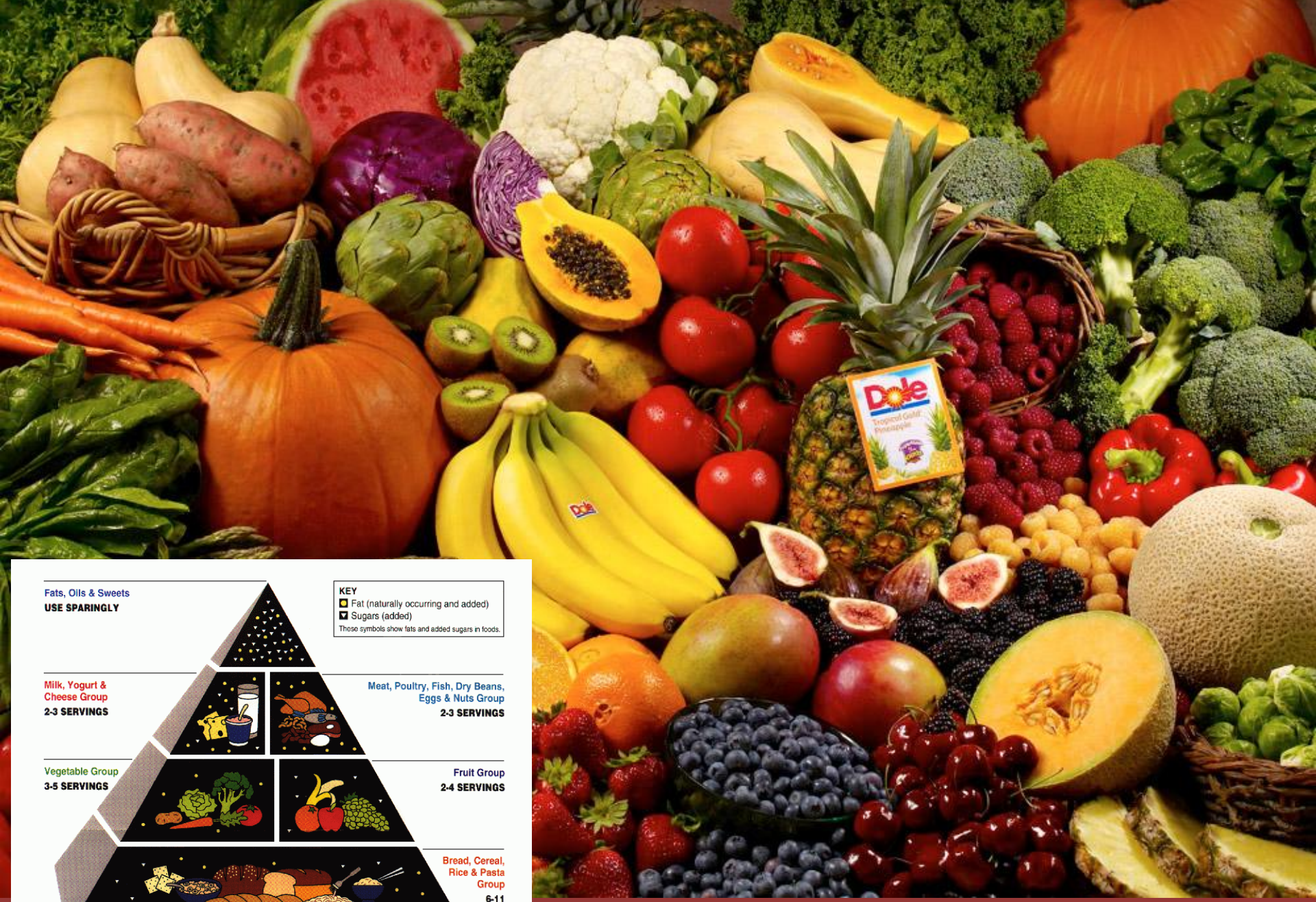
NS-S (Sorption) for Muscadine Juice

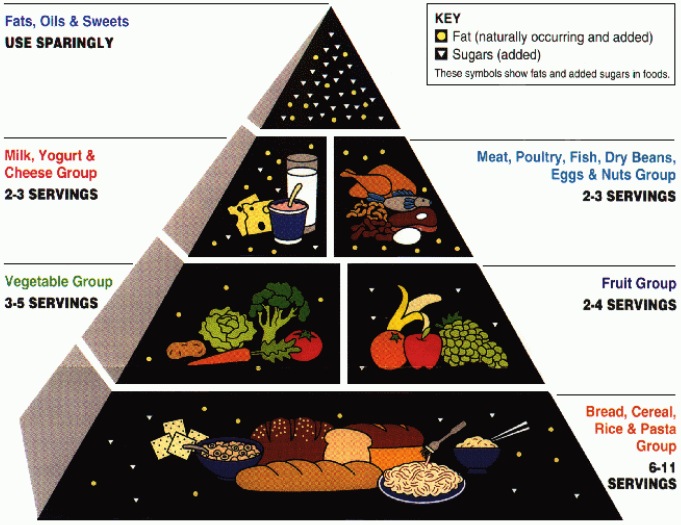
- **Efficient, One-Step, Sorption of the Medium Polarity Polyphenolic Compounds**
  (Polyphenolic Compounds are Sorbed and Stabilized by Protein-Rich Matrix)
- **Does Not Sorb Unwanted/Non-Nutritional Material**
  (Sugars, Pectin, and Excess Water are Removed with the Supernatant)

Hemp Flour w/50% Protein (HP50)



ADM Soy Protein Isolate (SPI)


Dole
Tropical Gold
Pineapple


Fats, Oils & Sweets
USE SPARINGLY
KEY
Fat (naturally occurring and added)
Sugars (added)
These symbols show fats and added sugars in foods.
Milk, Yogurt & Cheese Group
2-3 SERVINGS
Meat, Poultry, Fish, Dry Beans, Eggs & Nuts Group
2-3 SERVINGS
Vegetable Group
3-5 SERVINGS
Fruit Group
2-4 SERVINGS
Bread, Cereal, Rice & Pasta Group
6-11 SERVINGS